PUBLIC REPORT 2011

Part 1 - Corporation Details

Controlling Corporation

The University of Queensland

Period to which this report relates

From 1 July 2009 To 30 June 2011

Table 1.1 - Major Changes to Corporate Group Structure or Operations

Table 1.1 – Major Changes to Corporate Group Structure or Operations
As a result of a major flooding event in Brisbane early this year, The University of Queensland (UQ) sustained damage to some of its buildings and scientific greenhouses at the St Lucia campus. The State, represented by the Department of Environment and Resource Management (DERM) and the Department of Employment, Economic Development and Innovation (DEEDI), granted UQ temporary access and use of the State-owned Long Pocket Science Site at Meiers Road, Indooroopilly from 22 March 2011. A number of UQ facilities are no longer used. These include St Lucia small sites (ancillary to main site), Gatton small sites (ancillary to main site), Milton Library Warehouse, Split Yard Creek Research Station and Pinjarra Hills small sites (ancillary to main site). UQ has operational control over a number of entities. Newly formed entities under UQ operational control include Bioherbicides Australia Pty Ltd (registered 14 December 2010), Metallotek Pty Ltd (registered 16 November 2010), SnoreSounds Pty Ltd (registered 16 February 2010), UQ Health Care Ltd (registered 19 July 2010), Vaxxas Pty Ltd (registered 21 December 2010) and W2F Pty Ltd (registered 5 October 2010). UQ lost operational control over ALS Mineralogy Pty Ltd, Diabax Pty Ltd and Polyvacc Pty Ltd.

Table 1.2 – Aggregate energy assessed covered in this report

Total energy use covered by all assessments in this report	**122,210**	**GJ**
Total energy assessed as percentage of total energy use of the corporate group*#	**20.85**	**%**

* If this report covers only part of the corporate group, than the percentage should be computed on the total energy use for that part of the group covered in this report

Please note that corporations are required to assess 80% or more of their energy use in the first five-year assessment cycle and 90% or more in subsequent five-year assessment cycles. Accordingly, for those corporations with a 2005-06 trigger year (i.e. those corporations at the end of their first-five year assessment cycle), the value in “Percentage of corporation’s energy use assessed” above, must be more than 80%.

Declaration

Declaration of accuracy and compliance	
The information included in this report has been reviewed and noted by the board of directors and is to the best of my knowledge, correct and in accordance with the *Energy Efficiency Opportunities Act 2006* and *Energy Efficiency Opportunities Regulations 2006*.	**Professor Paul Greenfield** **Vice-Chancellor and President**
	Date 8/12/11

Part 2 - Assessment Outcomes

Table 2.1 – Assessment Details

Name of group member or business unit or key activity	St Lucia Campus

Total energy use in the last financial year	420,580	GJ
Energy use assessed in this entity as a percentage of total entity energy use*	27.51%	%
Energy use assessed in this entity as a percentage of total corporate energy use	19.74%	%
Accuracy of above estimates related to energy use assessed - <u>only required if not ±5% or better</u>	-	%

Period over which assessment was undertaken		01/07/2010		30/06/2011

Description of the way in which the entity carried out its assessment

The main campus of The University of Queensland (UQ) is located on a large bend in the Brisbane River at St Lucia about 10 km from the CBD. St Lucia Campus has over 33 major buildings, that is, buildings with GFA greater than 5000m^2. It has over 60 smaller buildings. A wide range of teaching, research, recreational and cultural activities is conducted on this campus.

During 2010/11 consultants conducted Level 1 energy audits on nine buildings at St Lucia and a Level 2 energy audit on one building, J D Story Building. The audits resulted in a large number of recommendations to improve energy use. Most covered lighting. In two of these buildings, the Queensland Biosciences Precinct and the Queensland Brian Institute, facility management personnel are exclusively assigned to the buildings and therefore they had sufficient local knowledge to start the process of retrofitting new lighting.

To facilitate implementation of the recommendations for the other audited buildings, detailed lighting surveys were carried out. This enabled the exact location of opportunities to be identified and scopes of work or retrofit specifications to be drawn up. Trials were conducted of different types of lighting improvements ranging from installation of occupancy sensors to control lights through to retrofitting fluorescent tubes with more efficient technology. A full scale trial retrofit of one building, the JD Story Building was carried out. Scopes of work were prepared for the lighting retrofits of the other audited buildings. Retrofit of these buildings is planned for 2011/12.

Having proven the system of lighting surveys, identification of specific opportunities and then carrying out implementation, a further 16 buildings on the St Lucia Campus were surveyed in 2010/11. Some of these are scheduled for retrofit projects in 2011/12.

Air conditioning at St Lucia is provided using chilled water produced in central chiller stations. St Lucia has 12 chiller stations serving multiple building precincts and two stand alone installations – chillers that serve just a single building. Presently the largest chilled water precinct, the Central Precinct, has 12 buildings (soon to be 14) served by a single chiller station. Understanding the production, distribution and use of chilled water at St Lucia, while challenging is essential to identifying efficiency opportunities.

A building control company was commissioned to audit the performance of three of the largest chiller stations. This exercise led to a number of recommendations which are being considered. It also provided an energy and performance baseline for future work. As a result of the audits a decision was taken to install permanent electrical and chilled water metering on each chiller in the three chiller stations (eight chillers in total) and create a network to monitor real time performance.

Following on from the chiller station audits, the University worked collaboratively with a consulting company and the local electricity distribution company, Energex, to explore opportunities for peak load reduction, or load shifting, on the Central Precinct.

The most promising energy efficiency opportunity was the retrofit of high efficiency motors on the pumps that move chilled water through the Central Precinct (see **Figure 1** below). Over 95% of the lifecycle cost of a water pump is electricity supply. High efficiency motors can save so much electricity that it can make sense to swap out old motors (and recycle their components) even if they still have plenty of life left in them. Replacing old motors is scheduled for 2011/12. Thermal energy storage (TES) using chilled water was also during the study considered, but found to be very costly. The use of phase change materials (other than water-ice) to store energy is however, under active consideration.

The space heating component of air conditioning at St Lucia is provided by way of electric duct heating. There are innumerable ducts heaters dispersed throughout buildings. Their number and location means that electricity consumption is not metered and consequently it is hard to put this form of electricity use in perspective and develop strategies for improvement. To deal with this issue the University worked with its building management control provider to develop a way of using information in the Building Management System (BMS) to deduce electrical consumption indirectly. A software template was developed and trialled in a building that had around 30 duct heaters. The results will be reviewed in 2011/12 with a view to rolling out this approach across the campus.

Finally, during 2010/11 the University commissioned an energy and comfort audit of the UQ Centre. The UQ Centre is the main graduation venue for the University. Students, their parents, relatives and friends, senior academic staff and dignitaries attend graduations and this provides an opportunity to showcase the University. For a number of years parts of the UQ Centre have, however, been uncomfortably hot at times during summer. The consultants recommended a multipronged strategy to reduce heat loads and improve comfort: improved lighting to reduce internal heat loads; window film for the eastern windows to block out solar heat gain; and better maintenance of the air conditioning systems to enhance energy efficiency and service delivery. This work was successfully completed in 2011/12.

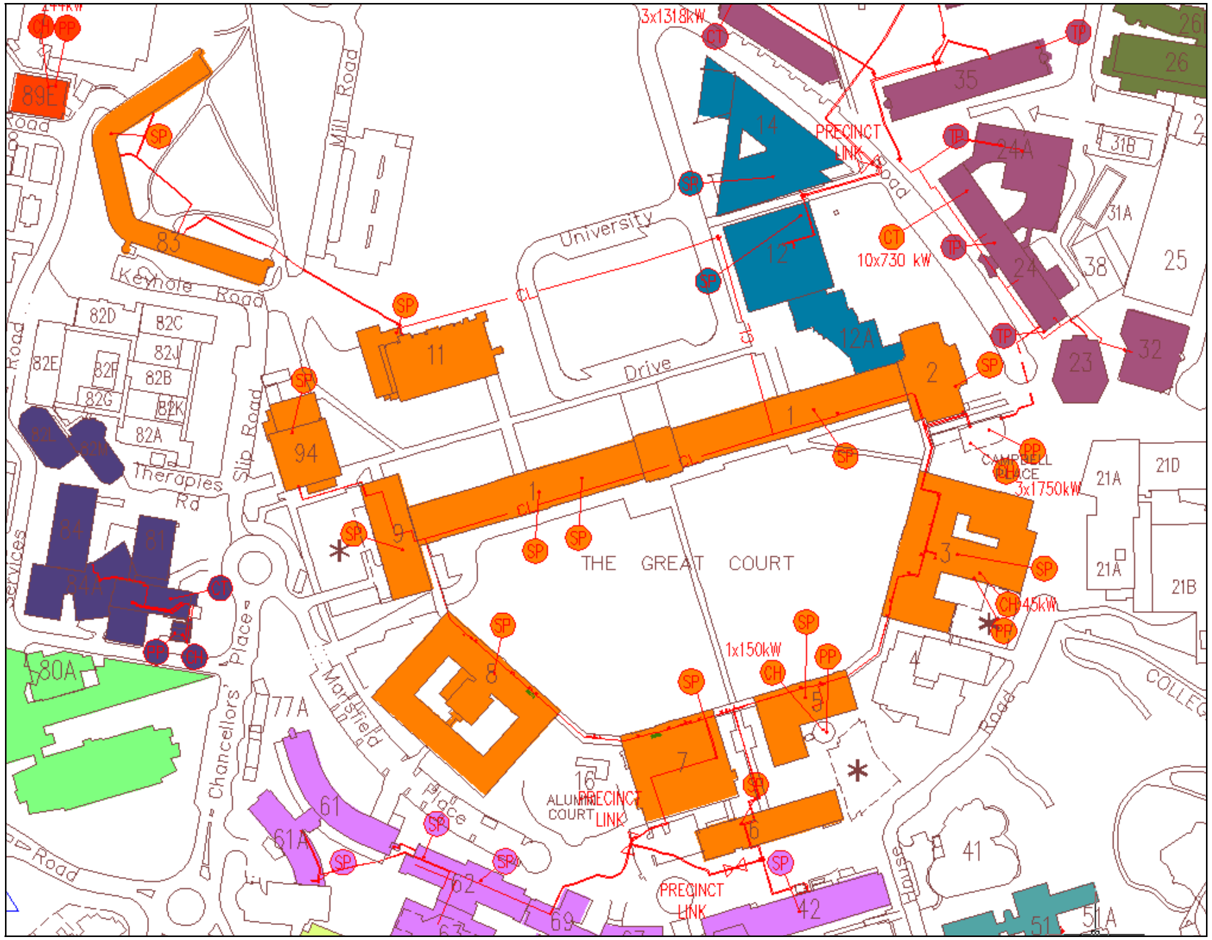


Figure 1: Central Chiller Precinct at St Lucia (orange fill) [PP & SP = Primary and Secondary Pumps]

Name of group member or business unit or key activity	Gatton Campus

Total energy use in the last financial year	53,067	GJ
Energy use assessed in this entity as a percentage of total entity energy use*	7.60%	%
Energy use assessed in this entity as a percentage of total corporate energy use	0.69%	%
Accuracy of above estimates related to energy use assessed - only required if not ±5% or better	-	%

Period over which assessment was undertaken		01/07/2010		30/06/2011

Description of the way in which the entity carried out its assessment

The UQ Gatton Campus is located adjacent to the Warrego highway at Gatton approximately 90 kms west of Brisbane. The main activities at Gatton are teaching and research associated with veterinary and agricultural science disciplines, food production and environmental management. Gatton has residential colleges to house students and accommodation for visiting staff. It also has administration, teaching and research buildings, a veterinary hospital and farm facilities such as a dairy, calf rearing sheds, piggery units and equine facilities.

During 2010/11, consultants conducted a Level 1 energy audit of the Centre for Advanced Animal Science (CAAS), a complex of buildings at Gatton. CAAS is a joint venture between the Queensland Department of Primary Industries and The University of Queensland. The CAAS complex comprises 24 buildings ranging from containment laboratories through to animal sheds.

CAAS is a relatively new complex and possibly as a consequence, no energy efficiency opportunities with paybacks of less than 4 years were discovered. The most promising opportunity (5 year payback) was the installation of occupancy CO_2 sensors to reduce the amount of outside air drawn into buildings (and hence the need to condition a large volume of air). This will be investigated further during 2011/12.

Two of the audit report's recommendations concerned hot water heating: to convert electric resistance storage heaters to heat pumps; and convert the storage heaters to solar boosted systems. As a consequence the University reviewed how water is heated at Gatton and noted other opportunities for improvement; converting LPG storage systems to instantaneous LPG and using heat recovery, such as from dairy refrigeration compressors, to preheat water. During 2011/12 these options will be investigated further and decisions will be made on whether to implement one or more options.

During 2010/11 the University became aware of an opportunity at Gatton to treat piggery and other waste streams via anaerobic digestion to produce methane. It may be possible to integrate this opportunity with other energy service proposals under investigation for Gatton in a way that reduces energy consumption - this possibility will also be investigated further in 2011/12.

Name of group member or business unit or key activity Ipswich Campus

Total energy use in the last financial year	15,497	GJ
Energy use assessed in this entity as a percentage of total entity energy use*	5.32%	%
Energy use assessed in this entity as a percentage of total corporate energy use	0.14%	%
Accuracy of above estimates related to energy use assessed - <u>only required if not ±5% or better</u>	-	%

Period over which assessment was undertaken 01/07/2010 30/06/2011

Description of the way in which the entity carried out its assessment

The UQ Ipswich Campus is located at Ipswich, approximately 40km west of Brisbane. The campus was established in 1999 on the site of an historic mental health facility. The campus consists of a mix of heritage buildings and relatively modern facilities. At Ipswich the University provides teaching, research and clinical activity in the Health Sciences, but also offers programs in the Arts and Education.

During 2010/11 two energy related initiatives took place at Ipswich. The production and distribution of chilled water was reviewed by consultants in the context of developing a chilled water master plan. The local electricity distribution company, Energex, requested the University also explore the potential for peak load reduction in the course of developing the master plan. Subsequently, a chilled water thermal energy storage (TES) proposal was developed for the Ipswich Campus. The TES project had the potential to save energy as well as shift load to off-peak periods. The cost to the University of a TES system turned out to be very high and a decision was taken not to proceed with the project.

The second initiative related to lighting. The University itself recognized that opportunities existed to improve both indoor and outdoor lighting. A decision was taken to conduct a detailed light technology survey of all indoor lighting at the campus in 2011/12 so that opportunities for improvement could be fully documented and implemented. There was a prima facie case for retrofitting the outdoor lighting with more efficient lamps; no light survey was needed to confirm this opportunity, so planning was advanced and the retrofit was scheduled for early 2011/12.

* Please note that, for individual sites that use more that 0.5PJ of energy, all energy use must be assessed (less a small proportion for non integral energy use).

Name of group member or business unit or key activity	Moreton Bay Research Station

Total energy use in the last financial year	1,086	GJ
Energy use assessed in this entity as a percentage of total entity energy use*	19.98%	%
Energy use assessed in this entity as a percentage of total corporate energy use	0.04%	%
Accuracy of above estimates related to energy use assessed - <u>only required if not ±5% or better</u>	-	%

Period over which assessment was undertaken		01/07/2010		30/06/2011

Description of the way in which the entity carried out its assessment

UQ's Moreton Bay Research Station (MBRS) is located at Dunwich on North Stradbroke Island which is on the eastern side of Moreton Bay and about 45 kms east of Brisbane. The MBRS is used to conduct marine research, to provide teaching facilities for University and secondary school students and it is also used as a conference venue.

In view of the high cost of electricity supplied to the MBRS, consultants were engaged to examine the feasibility of using renewable energy sources, namely solar hot water heating and PV to supply some of the Station's needs. During 2010/11, the University also engaged with consultants and the local electricity distribution company, Energex, to study peak load reduction opportunities at the MBRS. These studies improved our knowledge of the MBRS load profile and energy distribution across end uses and also indicated some general opportunities for energy efficiency improvements.

Subsequently, the University conducted a detailed survey of the lighting at the MBRS and drew up a scope of work for improvements; mainly replacement of T8 fluorescent tubes withT5 tubes and the use of voltage controllers. This work is planned for 2011/12.

The hot water system at MBRS is based on electric resistance storage cylinders and a pumped circulation loop. The existing shower head were replaced with super low flow heads which lowered hot water use by almost 15%. The circulation pump was placed on a timer and this has reduced heat losses from the long pipe network. The pipe insulation was also improved.

Solar heat gain to part of the MBRS is substantial and this adds to the air conditioning load. There is an opportunity to reduce this by fitting reflective film to north facing windows. This work is planned for 2011/12.

The renewable energy feasibility study mentioned above has led to a 40kW PV installation on the roof of the MBRS. While this does not qualify as an opportunity in terms of EEO legislation, the panels themselves create a secondary efficiency gain; they provide significant shade to the roof thus, reducing solar heat gain and load on air conditioning equipment. A solar hot water preheat system has also been installed on the MBRS.

The renewable energy feasibility and load reduction studies revealed that energy management at the MBRS would be improved by the installation of smart metering. Installation of two smart meters is planned for 2011/12 and once in place these are expected to assist with the identification of further energy efficiency opportunities at the MBRS.

* Please note that, for individual sites that use more that 0.5PJ of energy, all energy use must be assessed (less a small proportion for non integral energy use).

Name of group member or business unit or key activity | Heron Island Research Station

Total energy use in the last financial year	1,445	GJ
Energy use assessed in this entity as a percentage of total entity energy use*	100%	%
Energy use assessed in this entity as a percentage of total corporate energy use	0.25%	%
Accuracy of above estimates related to energy use assessed - <u>only required if not ±5% or better</u>	-	%

Period over which assessment was undertaken		01/07/2010		30/06/2011

Description of the way in which the entity carried out its assessment

Heron Island is located 72 kms NE of Gladstone, off the central Queensland coast. The island has the Delaware North Heron Island Resort, a Queensland Parks and Wildlife Service Ranger Station and the University's Heron Island Research Station (HIRS).

During 2010/11 Wide Bay Water Corporation administered a Commonwealth Government Green Precincts Project which was designed to improve energy efficiency, reduce water use and reduce the carbon footprint of activities on this World Heritage Site.

Wide Bay Water Corporation arranged a comprehensive audit by external consultants of energy and water use at the HIRS. The consultants visited the island and logged the energy consumption f key items of plant and equipment and built up an energy profile of the HIRS. They noted the technological status and operation mode of equipment and made recommendations for improving energy efficiency. Wide Bay Water Corporation then worked with UQ to action many of the recommendations. The University funded around two thirds of the cost of implementation and the balance came from the Green Precincts program.

One of the key Green Precincts projects, a 54 kW of photovoltaic installation, does not qualify as an EEO project, as it generates rather than saves energy; but a range of other Green Precinct projects have directly saved energy and do qualify.

Super low flow shower heads were installed resulting in energy savings of around 15% from the need to heat less hot water. Water on the island comes from the Resort's desalination plant, so water efficiency measures reduce the diesel consumption of the Resorts generators. This saving has not been attributed to UQ in this EEO report. Converting a number of hot water heaters from electric to instantaneous LPG heaters also reduced energy consumption overall, but again the saving is attributable to the Resort's generators.

The key projects that saved energy at the HIRS were: installing a variable speed (VS) drive and improved control on the HIRS seawater pump that supplies water to the teaching and research aquariums (and creates a fire fighting supply); placing timers on the air conditioning equipment so that it switches off when people are not present; improving the controls on food cold-rooms and freezers; and making improvements to lighting. These were all completed in 2010/11.

* Please note that, for individual sites that use more that 0.5PJ of energy, all energy use must be assessed (less a small proportion for non integral energy use).

Table 2.2 - Energy efficiency opportunities identified in the assessment

St Lucia Campus

Table 2.2 – Energy efficiency opportunities identified in the assessment									
Status of opportunities identified to an accuracy of better than or equal to ±30%		**Total Number of opportunities**	**Estimated energy savings per annum by payback period (GJ)**						**Total estimated energy savings per annum (GJ)**
			0 – < 2 years		**2 – ≤ 4 years**		**> 4 years**		
			No of Opps	**GJ**	**No of Opps**	**GJ**	**No of Opps**	**GJ**	
Business Response	Implemented	8	2	23	0	0	6	189	212
	Implementation Commenced	0	0	0	0	0	0	0	0
	To be Implemented	36	3	37	3	21	30	1,314	1,372
	Under Investigation	6	0	0	1	486	5	3,714	4,200
	Not to be Implemented	6	0	0	0	0	6	110	110
Outcomes of assessment	Total Identified	56	5	60	4	507	47	5,327	5,894
Status of opportunities identified to an accuracy of worse than ±30%									
Business Response	Implemented	5	0	0	3	123	2	65	188
	Implementation Commenced	0	0	0	0	0	0	0	0
	To be Implemented	24	11	396	6	66	7	93	555
	Under Investigation	35	7	356	7	102	21	391	849
	Not to be Implemented	27	1	9	0	0	26	652	661
Outcomes of assessment	Total Identified	91	19	761	16	291	56	1,201	2,253

Please note that Corporate Groups **are not required** to report opportunities with a payback greater than 4 years. Reporting this data is voluntary.

Gatton Campus

Table 2.2 – Energy efficiency opportunities identified in the assessment									
Status of opportunities identified to an accuracy of better than or equal to ±30%		Total Number of opportunities	Estimated energy savings per annum by payback period (GJ)						Total estimated energy savings per annum (GJ)
			0 – < 2 years		2 – ≤ 4 years		> 4 years		
			No of Opps	GJ	No of Opps	GJ	No of Opps	GJ	
Business Response	Implemented	0	0	0	0	0	0	0	0
	Implementation Commenced	0	0	0	0	0	0	0	0
	To be Implemented	0	0	0	0	0	0	0	0
	Under Investigation	0	0	0	0	0	0	0	0
	Not to be Implemented	1	0	0	0	0	1	196	196
Outcomes of assessment	Total Identified	1	0	0	0	0	1	196	196
Status of opportunities identified to an accuracy of worse than ±30%									
Business Response	Implemented	0	0	0	0	0	0	0	0
	Implementation Commenced	0	0	0	0	0	0	0	0
	To be Implemented	0	0	0	0	0	0	0	0
	Under Investigation	1	0	0	0	0	1	124	124
	Not to be Implemented	2	0	0	0	0	2	4	4
Outcomes of assessment	Total Identified	3	0	0	0	0	3	128	128

Please note that Corporate Groups **are not required** to report opportunities with a payback greater than 4 years. Reporting this data is voluntary.

Ipswich Campus

Table 2.2 – Energy efficiency opportunities identified in the assessment									
Status of opportunities identified to an accuracy of better than or equal to ±30%		Total Number of opportunities	Estimated energy savings per annum by payback period (GJ)						Total estimated energy savings per annum (GJ)
			0 – < 2 years		2 – ≤ 4 years		> 4 years		
			No of Opps	GJ	No of Opps	GJ	No of Opps	GJ	
Business Response	Implemented	0	0	0	0	0	0	0	0
	Implementation Commenced	0	0	0	0	0	0	0	0
	To be Implemented	1	0	0	1	145	0	0	145
	Under Investigation	0	0	0	0	0	0	0	0
	Not to be Implemented	1	0	0	0	0	1	1,260	1,260
Outcomes of assessment	Total Identified	2	0	0	1	145	1	1,260	1,405
Status of opportunities identified to an accuracy of worse than ±30%									
Business Response	Implemented	0	0	0	0	0	0	0	0
	Implementation Commenced	0	0	0	0	0	0	0	0
	To be Implemented	0	0	0	0	0	0	0	0
	Under Investigation	0	0	0	0	0	0	0	0
	Not to be Implemented	0	0	0	0	0	0	0	0
Outcomes of assessment	Total Identified	0	0	0	0	0	0	0	0

Please note that Corporate Groups **are not required** to report opportunities with a payback greater than 4 years. Reporting this data is voluntary.

Moreton Bay Research Station

Table 2.2 – Energy efficiency opportunities identified in the assessment									
Status of opportunities identified to an accuracy of better than or equal to ±30%		Total Number of opportunities	Estimated energy savings per annum by payback period (GJ)						Total estimated energy savings per annum (GJ)
			0 – < 2 years		2 – ≤ 4 years		> 4 years		
			No of Opps	GJ	No of Opps	GJ	No of Opps	GJ	
Business Response	Implemented	0	0	0	0	0	0	0	0
	Implementation Commenced	0	0	0	0	0	0	0	0
	To be Implemented	3	0	0	3	27	0	0	27
	Under Investigation	0	0	0	0	0	0	0	0
	Not to be Implemented	0	0	0	0	0	0	0	0
Outcomes of assessment	Total Identified	3	0	0	3	27	0	0	27
Status of opportunities identified to an accuracy of worse than ±30%									
Business Response	Implemented	0	0	0	0	0	0	0	0
	Implementation Commenced	0	0	0	0	0	0	0	0
	To be Implemented	1	0	0	1	17	0	0	17
	Under Investigation	0	0	0	0	0	0	0	0
	Not to be Implemented	0	0	0	0	0	0	0	0
Outcomes of assessment	Total Identified	1	0	0	1	17	0	0	17

Please note that Corporate Groups **are not required** to report opportunities with a payback greater than 4 years. Reporting this data is voluntary.

Heron Island Research Station

Table 2.2 – Energy efficiency opportunities identified in the assessment									
Status of opportunities identified to an accuracy of better than or equal to ±30%		Total Number of opportunities	Estimated energy savings per annum by payback period (GJ)						Total estimated energy savings per annum (GJ)
			0 – < 2 years		2 – ≤ 4 years		> 4 years		
			No of Opps	GJ	No of Opps	GJ	No of Opps	GJ	
Business Response	Implemented	7	0	0	2	203	5	73	276
	Implementation Commenced	0	0	0	0	0	0	0	0
	To be Implemented	15	0	0	0	0	15	96	96
	Under Investigation	0	0	0	0	0	0	0	0
	Not to be Implemented	0	0	0	0	0	0	0	0
Outcomes of assessment	Total Identified	22	0	0	2	203	20	169	372
Status of opportunities identified to an accuracy of worse than ±30%									
Business Response	Implemented	0	0	0	0	0	0	0	0
	Implementation Commenced	0	0	0	0	0	0	0	0
	To be Implemented	0	0	0	0	0	0	0	0
	Under Investigation	0	0	0	0	0	0	0	0
	Not to be Implemented	0	0	0	0	0	0	0	0
Outcomes of assessment	Total Identified	0	0	0	0	0	0	0	0

Please note that Corporate Groups **are not required** to report opportunities with a payback greater than 4 years. Reporting this data is voluntary.

Table 2.3 - Details of significant opportunities identified in the assessment

Opportunity 1 – Metering, Inventory, Prioritization and Expansion

A comprehensive, readily accessible metering system is a vital tool for identifying energy efficiency opportunities, analysing these and then monitoring the results of subsequent efficiency projects. A good metering system will also facilitate public communication and education through such means as website or building foyer displays of real time energy use and comparisons with benchmarks or the performance of other buildings.

At July 2010, UQ was thought to have a substantial electrical sub-metering network but details of the system were not consistently documented and interrogating the system to analyse energy patterns was time consuming. A program to systematically address these issues was rolled out during 2010/11:

Key Opportunities realised:

- Digital Power Meters were Documented and a Management Database was created;
- A Strategic Review was undertaken to Identify Priority Meters and Metering Gaps
- Chilled Water Energy Meters and Power Meters were installed on Chillers.

Metering schematics were prepared showing the position of meters on the high voltage and low voltage networks and hence the loads or sub-networks metered. The schematics contain a communication layer so that it is possible to visualise the relationship of meters to the IT network. Accurate metering schematics have enabled the identification of opportunities to create virtual meters and to cover gaps in the network. The schematics have been organised into a library linked directly to the meter management database (outlined shortly). Users can toggle between meter attributes in the management database and a visualisation of meter location and IT arrangements. **Figure 2** shows an example of metering schematic (note the virtual meter middle left).

Electrical power meters have a range of attributes that are important both for asset management and meter interrogation. Key attributes are: the IP address of the gateway that connects the meter to the LAN; the physical location of the meter; and the nature of the load monitored by the meter (its location and type - chiller, cooling tower, building light and power etc.). The Microsoft access database enables reports to be run on existing meters and allows new meters to properly documented and added to the system. It also plays an important role in navigating the metering system and thereby facilitates the production of reports on energy consumption and trends from specific meters. The database contains meters that measure on-site power production as well as consumption. **Figure 3** shows an extract from a report resulting from a search for all meters at the St Lucia Campus that measure PV output.

The metering schematics, the management data base and other information have enabled a strategic overview of metering at UQ and the subsequent identification of gaps. The UQ St Lucia campus for example has 33 buildings with GFA greater than 5000m^2. Of these buildings almost half – 15 buildings – do not have sufficient metering to enable a determination of the electrical consumption of the building. Scopes of work are being developed to roll out enough meters to cover these gaps.

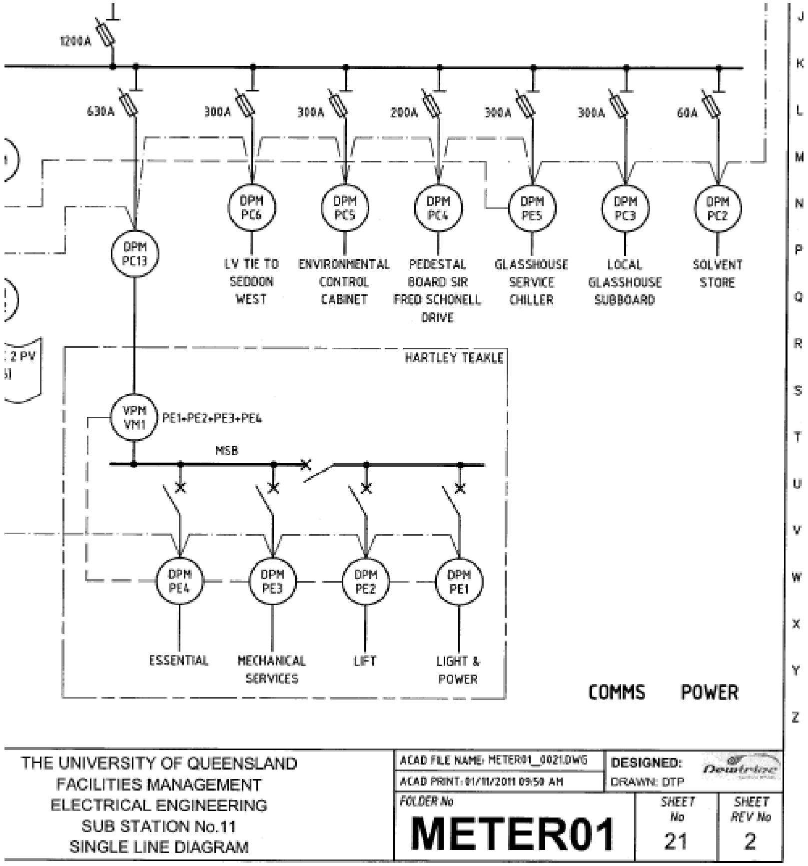


Figure 2: Metering Schematic Extract - Example

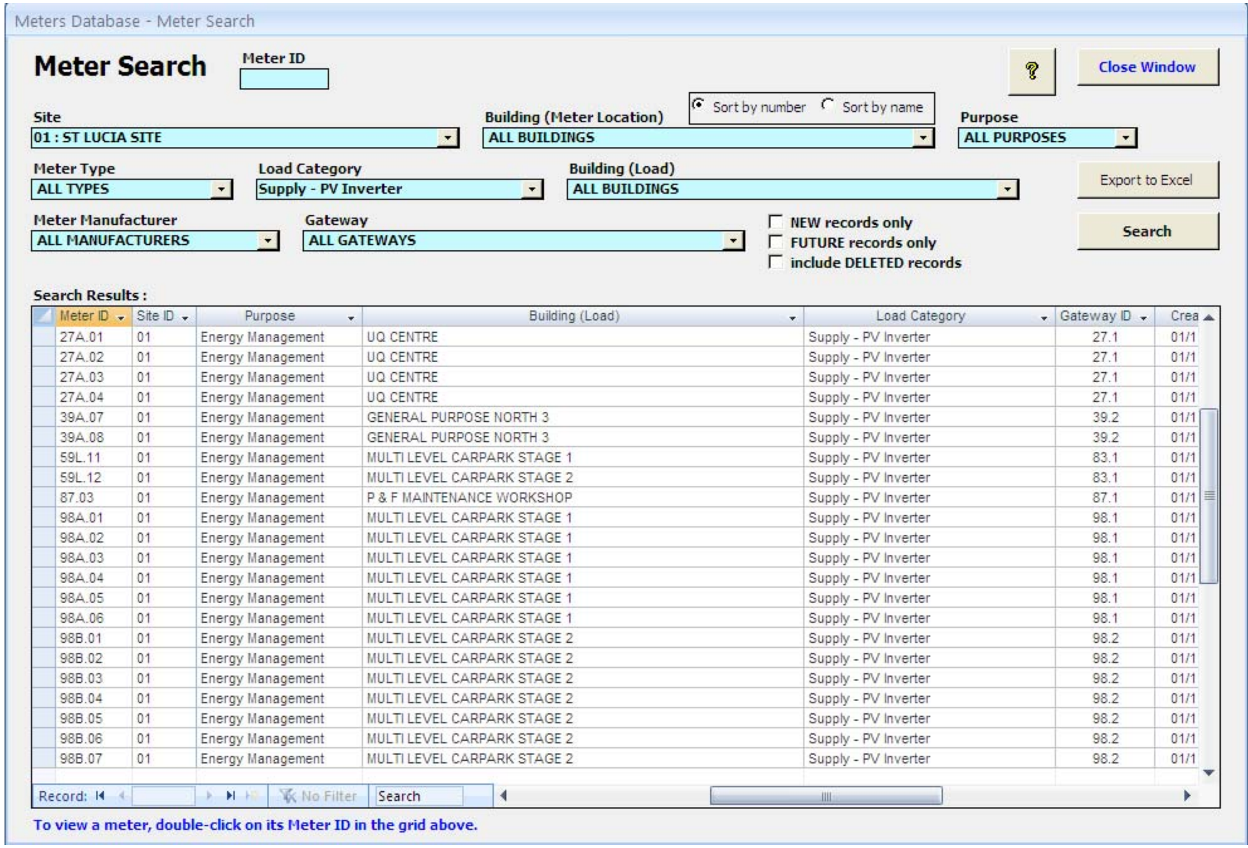
Air conditioning at UQ is mainly provided via chilled water networks serving air handling units or fan coil units. Central plant produce chilled water which is then distributed to buildings within the chiller precinct. In one case, 13 buildings are served by a single chiller station with three chillers. The energy consumed in the production of chilled water can represent 30% or more of the energy consumed in a building. Accounting for this energy is important when benchmarking buildings and monitoring changes in AC scheduling, adjustment of space set-points or making other improvements. At the start of 2010/11 the production and distribution of chilled water “energy” was not metered a UQ.

A program of works has been established to meter the production of chilled water from individual chillers and also to separately meter the electrical input to chillers, pumps and cooling towers. So far three major chiller stations with a total of 8 chillers have been completely metered. This means:

1. The efficiency of chillers (COP) can now be monitored to identify opportunities for changes in maintenance or operation to improve energy efficiency (same as for cooling towers);

2. The total electrical input to the production of chilled water can be determined and expressed as kWh per litre of chilled water per ^{o}C – or as kWh_e per GJ of heat rejected.

Most buildings already have flow meters that measure the amount of chilled water diverted to the building. These flow meters will be converted progressively to chilled water energy meters by the addition of suitable temperature sensors. Once this is done it will be possible to assign a share of the electrical energy used to produce and circulate chilled water through particular buildings. As mentioned earlier, this will facilitate better energy management of the buildings.



Meter ID	Site ID	Purpose	Building (Load)	Load Category	Gateway ID	Crea
27A.01	01	Energy Management	UQ CENTRE	Supply - PV Inverter	27.1	01/1
27A.02	01	Energy Management	UQ CENTRE	Supply - PV Inverter	27.1	01/1
27A.03	01	Energy Management	UQ CENTRE	Supply - PV Inverter	27.1	01/1
27A.04	01	Energy Management	UQ CENTRE	Supply - PV Inverter	27.1	01/1
39A.07	01	Energy Management	GENERAL PURPOSE NORTH 3	Supply - PV Inverter	39.2	01/1
39A.08	01	Energy Management	GENERAL PURPOSE NORTH 3	Supply - PV Inverter	39.2	01/1
59L.11	01	Energy Management	MULTI LEVEL CARPARK STAGE 1	Supply - PV Inverter	83.1	01/1
59L.12	01	Energy Management	MULTI LEVEL CARPARK STAGE 2	Supply - PV Inverter	83.1	01/1
87.03	01	Energy Management	P & F MAINTENANCE WORKSHOP	Supply - PV Inverter	87.1	01/1
98A.01	01	Energy Management	MULTI LEVEL CARPARK STAGE 1	Supply - PV Inverter	98.1	01/1
98A.02	01	Energy Management	MULTI LEVEL CARPARK STAGE 1	Supply - PV Inverter	98.1	01/1
98A.03	01	Energy Management	MULTI LEVEL CARPARK STAGE 1	Supply - PV Inverter	98.1	01/1
98A.04	01	Energy Management	MULTI LEVEL CARPARK STAGE 1	Supply - PV Inverter	98.1	01/1
98A.05	01	Energy Management	MULTI LEVEL CARPARK STAGE 1	Supply - PV Inverter	98.1	01/1
98A.06	01	Energy Management	MULTI LEVEL CARPARK STAGE 1	Supply - PV Inverter	98.1	01/1
98B.01	01	Energy Management	MULTI LEVEL CARPARK STAGE 2	Supply - PV Inverter	98.2	01/1
98B.02	01	Energy Management	MULTI LEVEL CARPARK STAGE 2	Supply - PV Inverter	98.2	01/1
98B.03	01	Energy Management	MULTI LEVEL CARPARK STAGE 2	Supply - PV Inverter	98.2	01/1
98B.04	01	Energy Management	MULTI LEVEL CARPARK STAGE 2	Supply - PV Inverter	98.2	01/1
98B.05	01	Energy Management	MULTI LEVEL CARPARK STAGE 2	Supply - PV Inverter	98.2	01/1
98B.06	01	Energy Management	MULTI LEVEL CARPARK STAGE 2	Supply - PV Inverter	98.2	01/1
98B.07	01	Energy Management	MULTI LEVEL CARPARK STAGE 2	Supply - PV Inverter	98.2	01/1

Figure 3: Sample report from Meter Management Database.

The metering priorities for 2011/12 have been identified:

1. Continue to install new electrical and chilled water energy meters to cover strategic gaps;
2. Develop meter design guidelines for new buildings and major refurbishments; and
3. Install software to readily enable reports on energy use and trends to be produced.

Points 2 and 3 will be briefly elaborated.

It is more cost effective to installed meters from the outset in new buildings and during major refurbishments than retrofitting them later. Retrofitting chilled water energy meters on to existing chillers is particularly difficult. A design guideline will be developed to indicate which loads should be metered and how. It will apply to all plant upgrades or replacements and building work.

UQ already has a system of data acquisition, retrieval and rendering that enables tables and graphs of energy consumption and trends to be produced using the data from some meters. The system can be used to produce benchmark reports like the one shown in **Figure 4** for example, but a considerable amount of manual handling of data is needed. During 2011/12, UQ is planning to install a new software front end and undertake the system integration necessary to create a user friendly reporting system – a system that can be readily used by students, researchers, facilities engineers and consultants. This will improve overall visibility of the system and this in turn is expected to lead to identification of a greater number of energy efficiency opportunities than is presently possible.

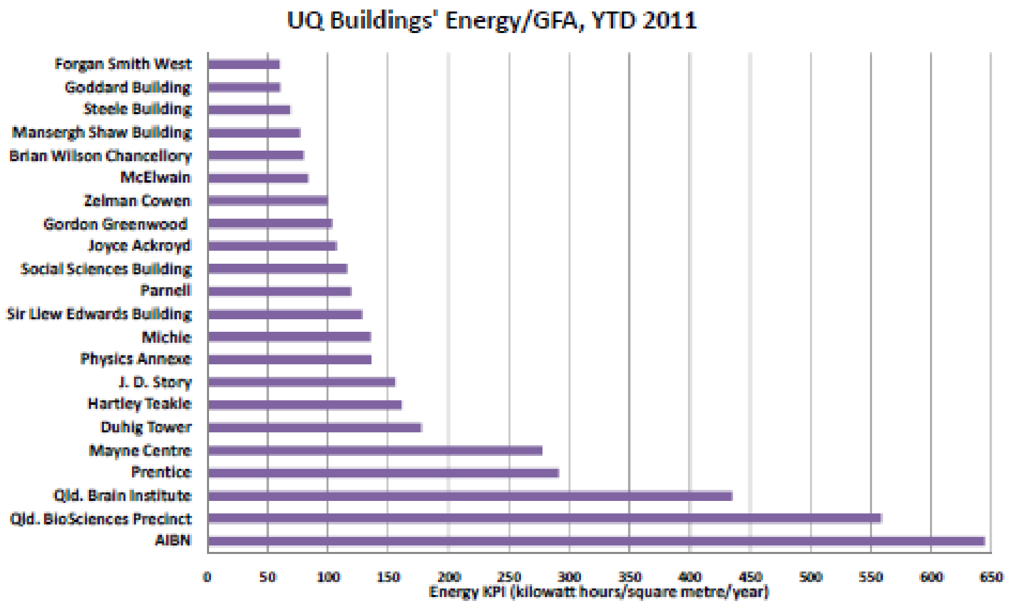


Figure 4: Sample Building Benchmark Report – kWh/m² GFA - 2011 YTQ3

Opportunity 2 – Lighting Surveys, Data Management and Retrofits

Building audits conducted during 2010 revealed a common theme; opportunities were present to improve lighting through a range of measures:

- Retrofitting T5 fluorescent tubes in suitable T8 fittings (those with electromagnetic ballasts);
- Swapping 50W dichroic lamps with 35W high efficiency infrared coating (IRC) lamps;
- Replacing 50W lamps with LEDs where existing light levels were higher than needed;
- De-lamping – removing one tube from a twin fitting where light levels were high; and
- Fitting voltage controllers to T8 magnetically ballasted fluorescent lighting circuits
- Installing passive infrared (PIR) occupancy sensors and piezoelectric (PE) daylight sensors to turn lights off when not needed.

The challenge faced by UQ was to develop a cost effective way of realising these opportunities without creating unintended consequences now, or maintenance problems down the track. The following strategy was adopted:

1. Conduct trials to identify pro and cons of each approach and develop scopes of work;
2. Establish some rules of thumb to identify the characteristics of cost effective opportunities;
3. Create a light survey methodology and data management system;
4. Prove the survey and management system through a whole building trial

Installing PIR sensors in multi-cubicle toilet blocks can, for example, create a problem if lights switch off while people are still present, but are not detected by a sensor. A solution was successfully trialled: installation of low wattage light-emitting diode (LED) pilot lights that remain on when the main lights are turned off by the PIR. This solution provides a good balance of energy efficiency, OH&S and personal security. Through various trials the limitations of each approach were discovered and necessary mitigation measures were established.

Lighting audits often recommend generic upgrades (replace T8 fluorescent tubes with T5 tubes), but any given opportunity may not be cost effective in a particularly situation. On the other hand, the cost of doing a detailed financial analysis for every case creates an overhead that can counter the benefits of a particular proposal. This issue is usually dealt with by using rules of thumb – generalisations about the scale or thresholds within which a type of project remains cost effective. Rules of thumb are easy to apply and will lead to right conclusion most of the time.

UQ, like other universities, is an expensive place to carry out retrofit work. Meanwhile as a mixed blessing, as a bulk purchaser, UQ is able to obtain electricity on very favourable terms. This means that standard energy efficiency rules of thumb do not readily apply at UQ.

In the course of conducting lighting trials UQ was also able to develop its own rules of thumb or the range of lighting opportunities listed above. Voltage controllers, for example, come in different sizes. For each size, the minimum number of tubes that need to be connected to the controller, to create a cost effective outcome, was determined. Similarly the minimum amount of lighting (wattage) that should be controlled by a PIR to make this retrofit worthwhile was also established. This means that the University now has some idea of the opportunities it should be looking for.

The next challenge that faced UQ was finding the opportunities. Buildings at the St Lucia campus, for example, contain a mixture of very old fit-outs and new refurbishment. A single floor could contain a wide range of lighting technologies. The most cost effective work process for UQ was to identify the lighting technology in place, review it, identify specific retrofit opportunities and then let contracts to carry out the work. Electrical contractors could then plan around a specific number and type of retrofit for each building. They would also know the exact location of each opportunity (building, floor and room number).

Consequently a lighting survey methodology was developed. Initially a system using handwritten records and entry to Excel was used. Then to increase productivity and reduce entry error, an iPad based field data entry system was developed (**Figure 5** below). The full system was then tested from survey through to retrofit at a full scale building scale. A combination of lighting improvement measures were applied to the JD Story Building, one of the main administration buildings on the St Lucia campus. This was highly successful. 122 T8 tubes and 77 50H lights were replaced by LED and T5 tubes, respectively.

In 2010/11 10 buildings were surveyed. Early in 2011 a second more challenging building was retrofitted. The survey based approach is now considered proven and a further eight buildings are planned for retrofit before the end of 2011.

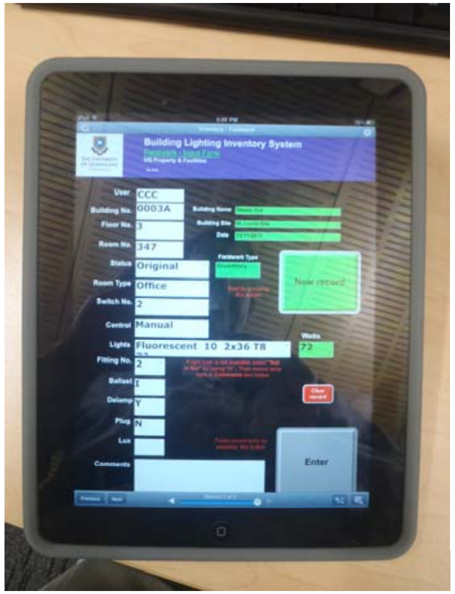


Figure 5: Lighting Technologies - iPad Based Field Data Entry

Opportunity 3 – UQ Centre Comfort and Energy Efficiency Improvements

The UQ Centre is the main graduation venue for the University. Students, their parents, relatives and friends, senior academic staff and dignitaries attend graduations. As well as being a major milestone in a student's life, graduation it is also an opportunity for the University to showcase itself.

For a number of years parts of the UQ Centre have, however, been uncomfortably hot at times during summer, hot to the point that the experience of graduation has been compromised. The main foyer and the eastern corridor have only limited air conditioning and ventilation. These areas get a lot of hot morning sun in summer. When large numbers of people are gathered problems inevitably develop. The boardroom and VIP room, where academics and dignitaries prepare for the ceremonies, struggle to maintain comfortable conditions when the hot morning sun strikes the east side of the building. Consultants were engaged to conduct an energy audit of the whole UQ Centre and in the process also develop means of improving both energy efficiency and user comfort.

A multipronged strategy was adopted: improved lighting to reduce internal heat loads; window film for the eastern windows to block out the sun; and better maintenance of the air conditioning systems to enhance energy efficiency and service delivery.

Figure 6: UQ Centre Eastern Facade

Window Film
The eastern facade of the UQ centre is almost entirely glass and is exposed to the summer sun from just after sunrise to almost 11am. Mirror window film was examined as a heat load reduction strategy. A key consideration was to avoid sun strike or glare from reflected sunlight for a number of key third parties: bus drivers that used a bus stop and turning zone at the UQ end of the Eleanor Schonell Bridge; people driving vehicles (including bicycles) along Sir William McGregor Drive; sports persons and spectators on adjacent playing fields; and the residents of houses on the opposite side of the Brisbane River. A sun path and reflection analysis was conducted and this indicated that any problem was confined to a small geographic area and a short time period very early in the morning.

A trial installation of the film revealed another type of problem, however. UQ prides itself on the prolific wildlife that coexists with the human activities on the St Lucia campus. Unfortunately Spur Winged Plovers (or Masked Lapwings) decide to attack their reflections in the mirror film. As attacks were launched from ground level, an 800mm high bird band – a see through perforated film - was placed over the bottom of the mirror window film. This band retained the thermal performance of the mirror film but broke up the reflected images thus deterring further attacks by the birds (Please see **Figure 7**).

Figure 7: 800mm High Bird Band

It is estimated that the mirror film has reduced the heat load to the extent that the air conditioning system uses 15MWh of electricity less each year. It has also contributed to improved comfort during graduations.

Lighting Upgrades
The heat from inefficient lighting was adding to comfort problems in the UQ Centre. In the eastern corridor sixty 50W 12V dichroic halogen down-lights were replaced with 7W 240V LEDs. The 240V LEDs do not need a driver or a transformer, so they save another 6 watts of power per fitting over and above the difference in lamp wattage. The results have been excellent. Light levels have actually improved - the reflectors on the original lamps had failed causing a loss of output. The original light design resulted in over lamping. The new installation meets code requirements and has reduced energy consumption by around 85%.

30W halogen down-lights shining on countertops in both the boardroom and VIP room were replaced with the 7W LEDs resulting in energy savings of over 75%. Some thirty 50W bi-pin halogen lamps in the VIP room will be replaced with the same low wattage super efficient LEDs. The bi-pin 50W halogen lamps in the boardroom are not suited to an LED replacement. Instead new high efficiency 35W IRC lamps were installed resulting in energy savings, longer life and better light output.

Overall the lighting changes are saving just under 6kW of power and provide as good or better light levels than at present. Many of the existing short life lamps have been replaced with lights that will last for years. The work has improved comfort levels, while lowering future energy and maintenance costs.

The main foyer still has around 200 50W halogen down-lights on a very high ceiling. These will be replaced with LEDs during the 2011/12 year. There are also plans to upgrade the lighting in the car park under the UQ Centre during 2011/12.

Enhanced Maintenance
A range of maintenance problems were discovered by examining all plant and equipment in the field and looking at its performance on the Building Management System:

- Faulty chilled water valve actuators (locked open)
- Failed/inaccurate thermostats (poor control feedback)
- Leaky ductwork (loss of conditioned air to non occupied spaces
- Stuck or broken dampers (inability to use economy cycle.

These faults were corrected so that plant and equipment could operate to its full potential. The costs involved were low and not thought to warrant an energy savings estimate and payback analysis. Most of the maintenance work would have reduced energy consumption and all of it would have improved service delivery.

The possibility of improving the operating regime of the air conditioning equipment in the UQ Centre is now being examined. The main auditorium, for example, uses 100% outside air (after a short start up recycle phase); it may be possible use CO_2 sensors to tailor the amount of outside air brought into the space to suit actual occupancy levels. This work is scheduled for 2011/12.

Please note that the "Description of the Opportunity" above should include information on the specific nature and type of opportunity, as well as information on the type of equipment and/or process involved.